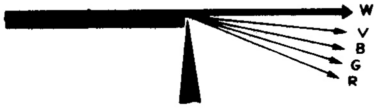
The Behavior of Light (Part I)

I. The Nature of Light

A. The Law of Rectilinear Propagation: Light GENERALLY travels in straight lines at a constant speed in any given medium. The word generally is used because there are two exceptions:

1. In space, the gravitational pull of some very large objects (like the sun) can cause a slight bend in the otherwise straight path of light. This indicates that photons have a small mass.

2. Diffraction - light rays that pass near all opaque edges are bent slightly. Consequently, small lens openings adversely affect the sharpness of an optical image.



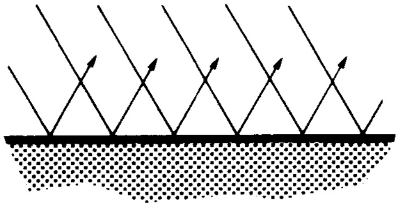
B. The Inverse Square Law states that the amount of light which falls on an object varies INVERSELY with the square of the distance the object is from the light's source. The law must be considered anytime artificial light is used for photography, but is literally true only for a point source without a reflector.

II. The RAT Formula (Reflection, Absorption, Transmission):

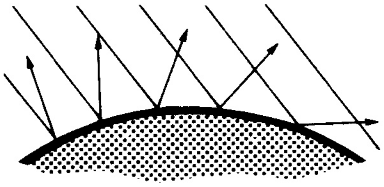
A. Reflection - Light bounced off a surface

1. Specular reflection - occurs on smooth, polished surfaces (mirror, water, etc.), and the reflected rays travel in an orderly fashion.

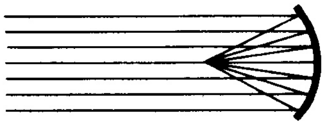
   a. flat polished surface - reflected rays will be parallel.



   b. convex polished surface - reflected rays diverge.



   c. concave polished surface - reflected rays converge.



2. Diffuse reflection - occurs on dull, matte surfaces, and the paths of reflected light rays are not orderly (i.e., The light is bounced in all directions because of an uneven surface.) If a high percentage of light is reflected by a diffuse surface, it appears bright. If a low percentage is reflected, it appears dark.

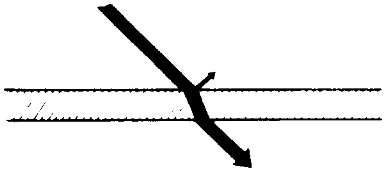
3. Selective or Non-selective Reflective Surfaces

a. selective - reflects some light wavelengths more readily than others - reflected light is colored.

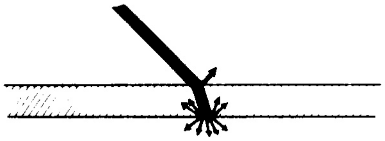
b. non-selective - reflects equally all light wavelengths. Reflected light is neutral if incident light is neutral.

B. Transmission - light passes through a medium. This medium may be:

1. transparent - light passes through in an orderly fashion. Objects can be seen clearly through a transparent medium.



2. translucent - light passes through in a disorderly fashion. Objects cannot be seen clearly through a translucent medium.



3. Selective or Non-selective Transmitting Media.

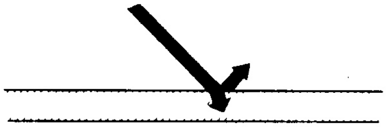
a. selective - transmits some light wavelengths more readily than others. (colored)

b. non-selective - transmits equally all light wavelengths. (neutral)

C. Absorption: All incident light not reflected or transmitted by an object is absorbed by it.

1. The energy of absorbed light is changed to heat energy by the process of absorption.

2. If all light not reflected is absorbed, so that there is no transmission, the object is opaque.



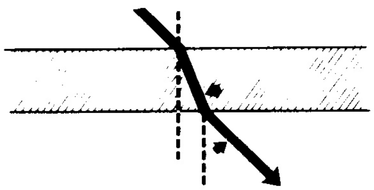
The Behavior of Light (Part II)

I. Refraction - the bending of light rays as they pass from a medium of one density to a medium of a different density.

A. Refraction is caused by light's change in speed as it passes through materials of differing optical densities.

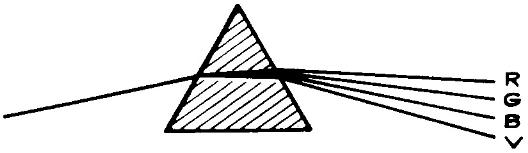
1. Light bends toward the perpendicular when entering a more dense medium.

2. Light bends away from the perpendicular when entering a less dense medium.



B. Index of Refraction (n) - the speed of light in air divided by its speed in another medium.

C. Dispersion - the separation of white light into its component colors while being refracted.



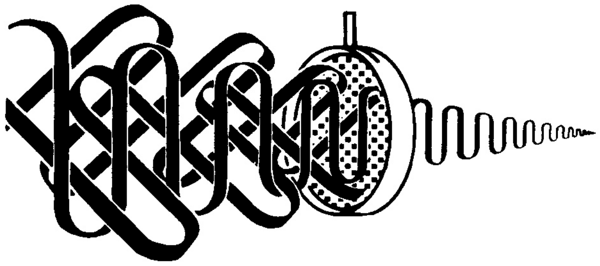
1. Optical materials have different indices of refraction for different wavelengths of light.
    a. high index for short waves, which are bent more
    b. low index for long waves, which are bent less
2. Dispersion produces a colored fringe effect in photos taken with simple lenses. More expensive cameras have multiple glass elements, designed (color-corrected) to eliminate color fringes.

II. Interference - light waves are reflected from both the front and rear surfaces of a very thin optical material producing a brighter or darker reflection (depending on the thickness of the material).

A. In a camera, reflection from the lens surfaces can cause unwanted light to reach the film, which lowers the image contrast.

B. An interference coating (magnesium flouride) is used to reduce the intensity of reflections at each lens surface, thereby increasing image contrast.

III. Polarization - The change is neutral light, where vibrating in all directions, to polarized light whose vibration is in only one direction. A polarizing filter is used to:



A. reduce specular reflections or glare from water and non-metal surfaces.

B. make the sky appear a darker blue in color photos.

IV. Atmospheric "Scattering" - the absorption and re-radiation of certain sunlight wavelengths by molecules of atmospheric gases, dust, and/or moisture.

A. Atmospheric "scattering": makes the sky appear blue, sunset yellow, or red.

B. Outer space appears black because it has no atmospheric molecules to scatter sunlight.

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